US012431675B2

(12) **United States Patent**
Kumamoto

(10) **Patent No.: US 12,431,675 B2**
(45) **Date of Patent: Sep. 30, 2025**

(54) **CABLE CONNECTOR ASSEMBLY**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 373 days.

(21) Appl. No.: **17/729,602**

(22) Filed: **Apr. 26, 2022**

(65) **Prior Publication Data**

US 2022/0255273 A1 Aug. 11, 2022

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2020/040277, filed on Oct. 27, 2020.

(30) **Foreign Application Priority Data**

Nov. 1, 2019 (JP) 2019-199527

(51) **Int. Cl.**
H01R 24/40 (2011.01)
H01R 4/18 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01R 24/40*** (2013.01); ***H01R 4/183*** (2013.01); ***H01R 13/516*** (2013.01); ***H01R 13/6592*** (2013.01)

(58) **Field of Classification Search**
CPC H01R 24/40; H01R 4/183; H01R 13/516; H01R 13/6592; H01R 2103/00;
(Continued)

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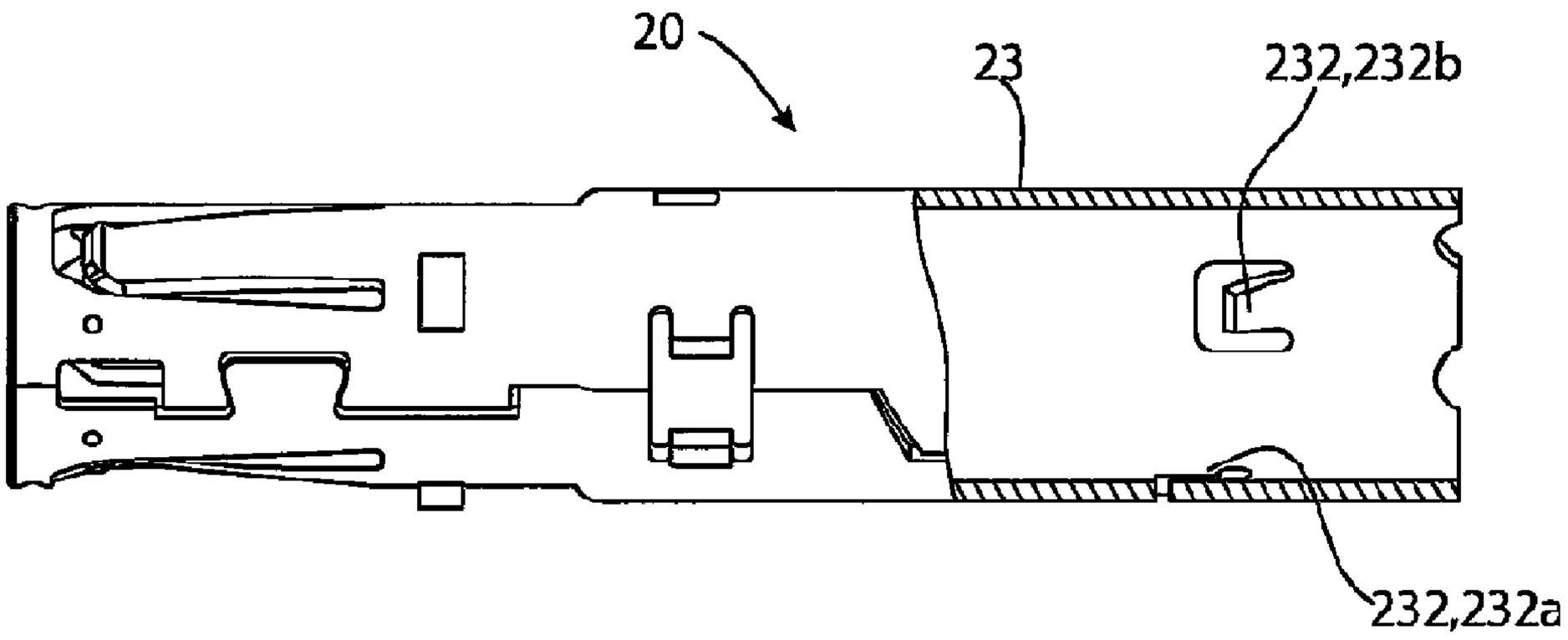
(57) **ABSTRACT**

A cable connector assembly includes a coaxial connector, a shielded cable, and a ferrule. The coaxial connector has an inner terminal, an insulating housing surrounding the inner terminal, and an outer terminal surrounding the insulating housing. The shielded cable has an inner conductor connected to the inner terminal, an insulation layer surrounding the inner conductor, and an outer conductor surrounding the insulation layer. The ferrule is positioned inside the outer terminal and crimped to the outer terminal. The outer terminal has a plurality of catching portions formed in different positions in an axial direction of the shielded cable and catching on the ferrule to restrain the shielded cable from being pulled out.

18 Claims, 6 Drawing Sheets



(51) **Int. Cl.**
H01R 13/516 (2006.01)
H01R 13/6592 (2011.01)

(58) **Field of Classification Search**
CPC H01R 9/0518; H01R 13/639; H01R 4/184; H01R 13/02; H01R 24/38; H01R 13/59; H01R 13/64; H01B 7/00
See application file for complete search history.

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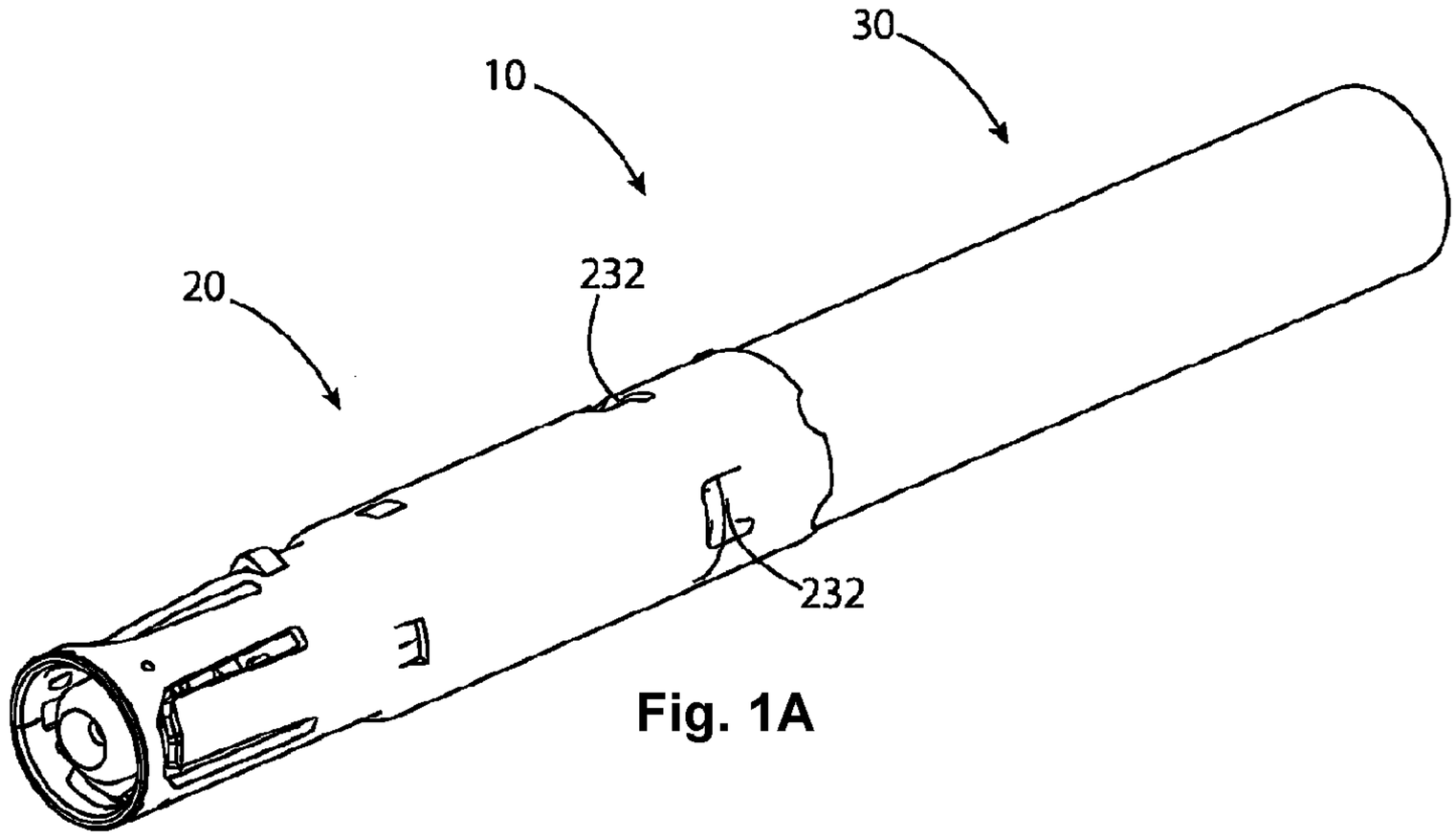

Fig. 1A

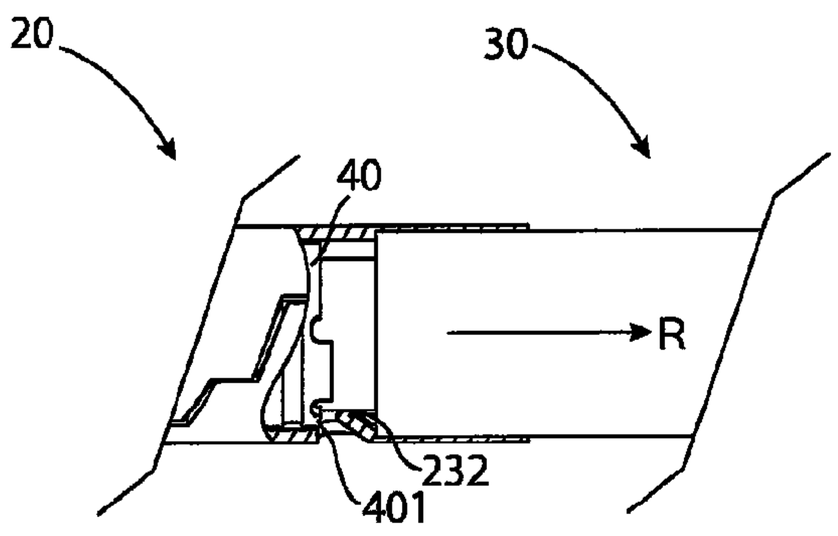

Fig. 1B

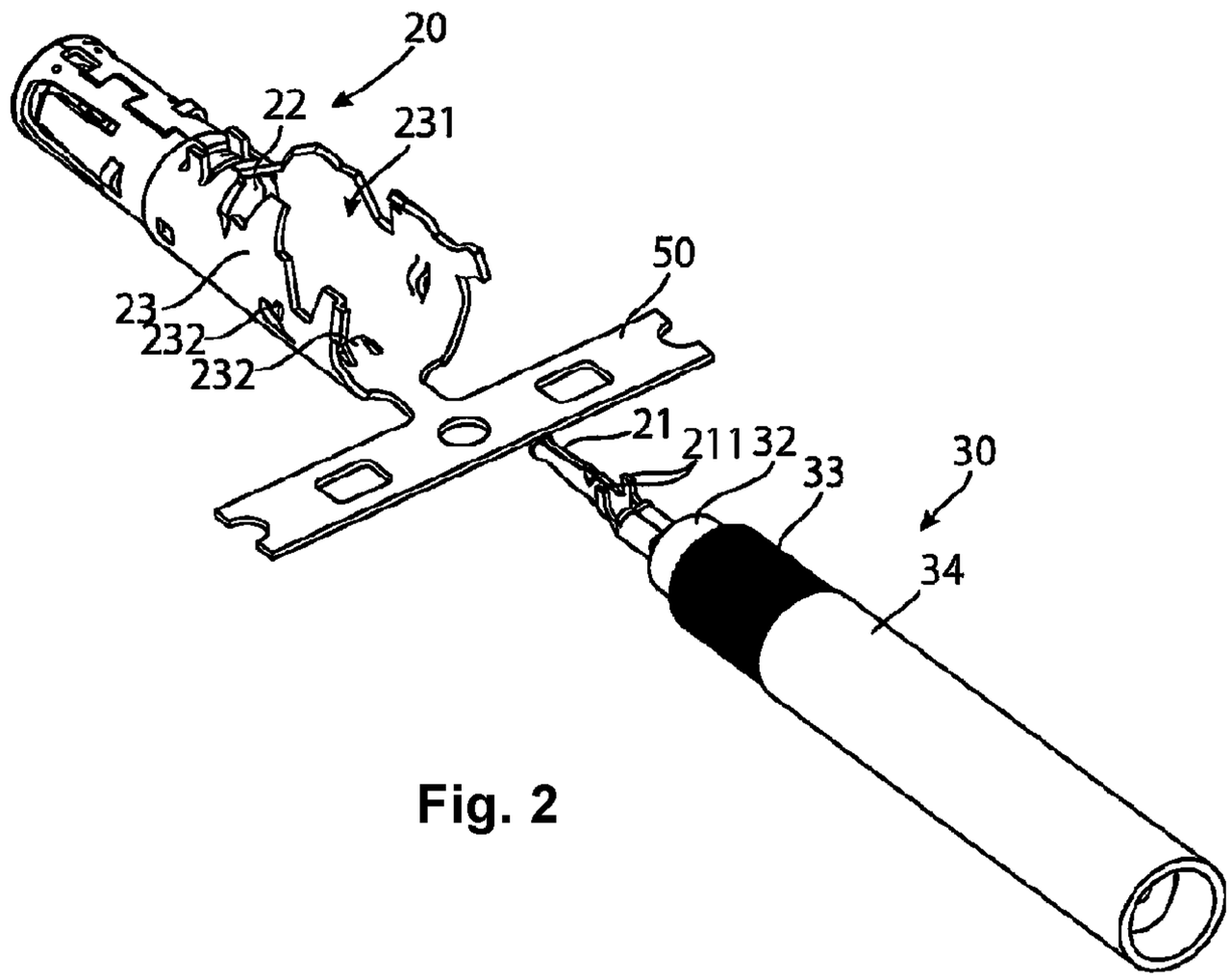

Fig. 2

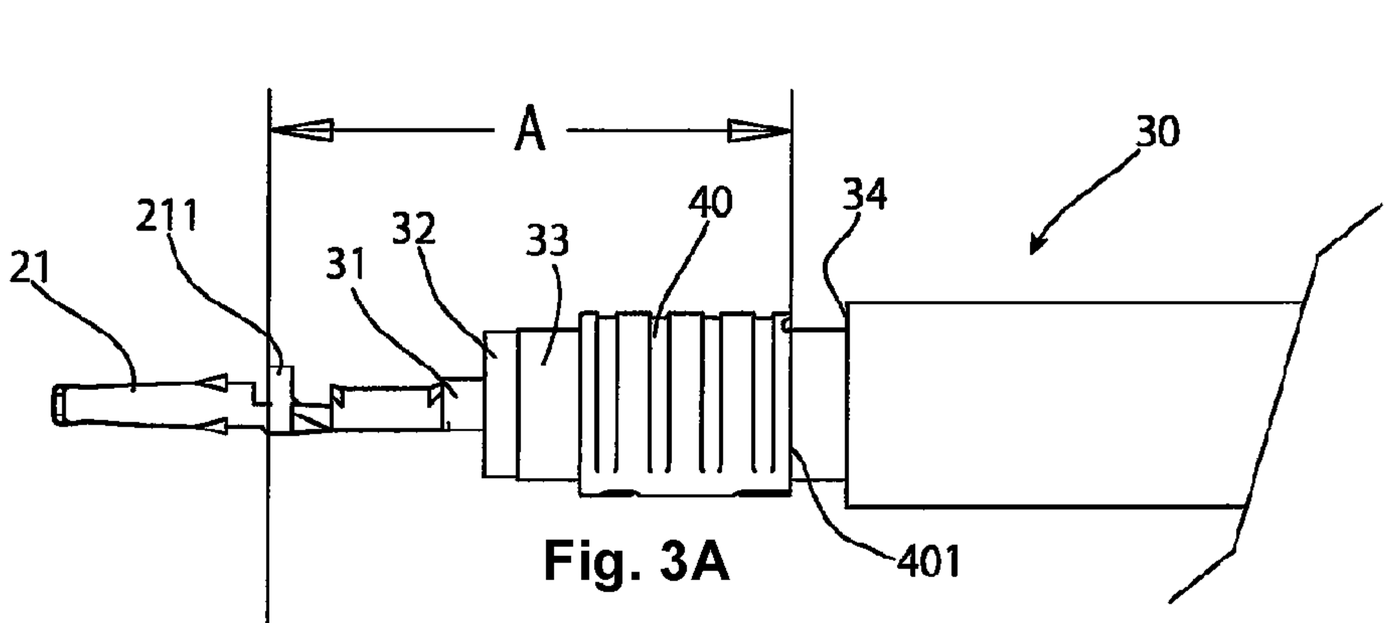

Fig. 3A

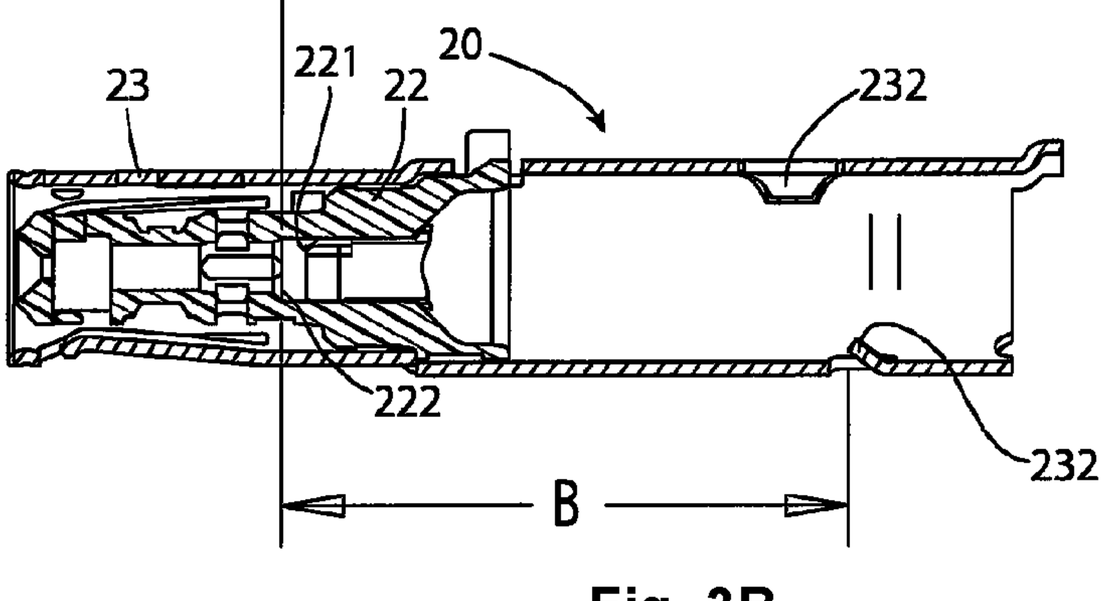

Fig. 3B

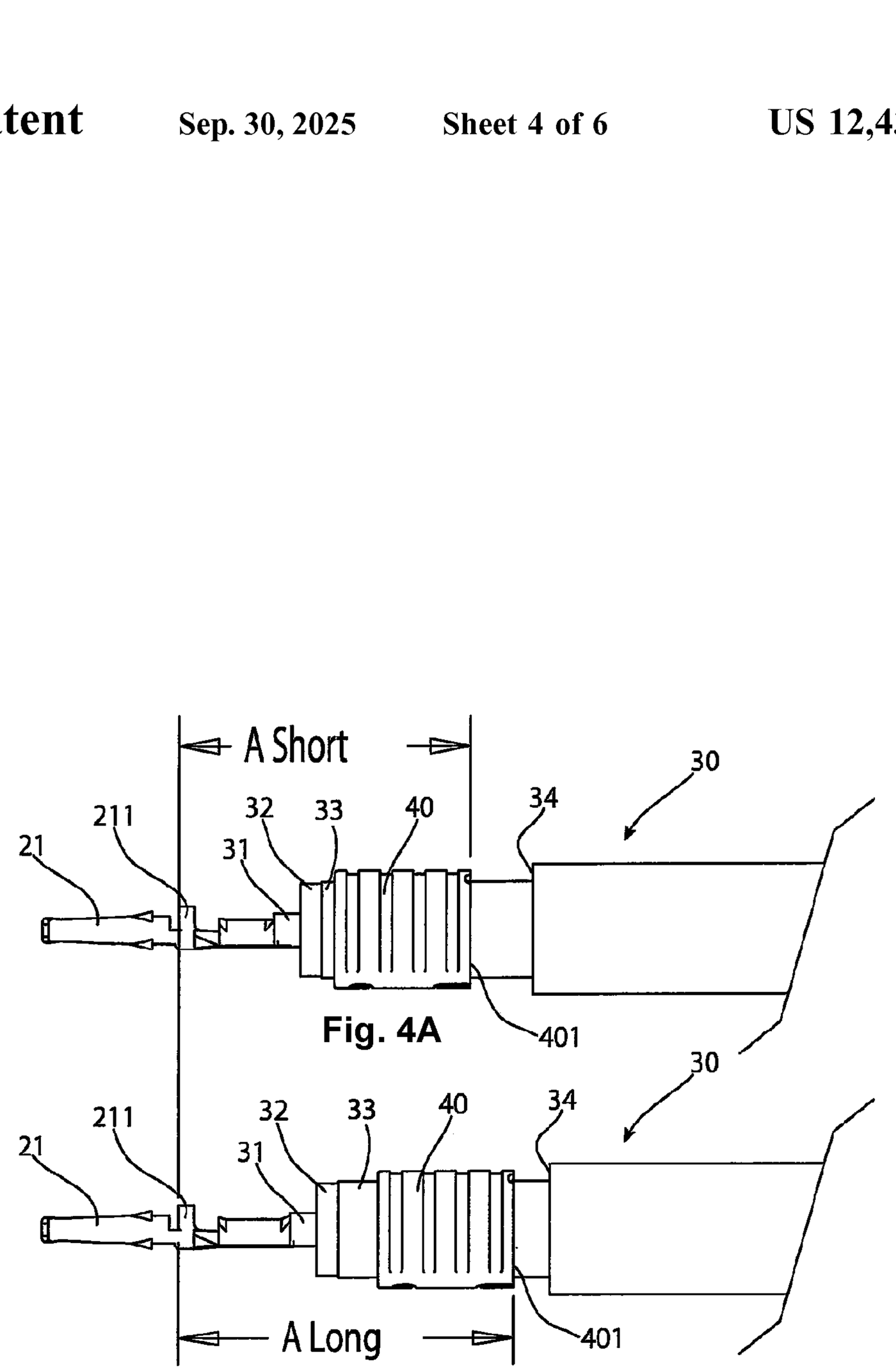
A Short
30
34
211
32
33
40
21
31
401

Fig. 4A

30
34
211
32
33
40
21
31
A Long
401

Fig. 4B

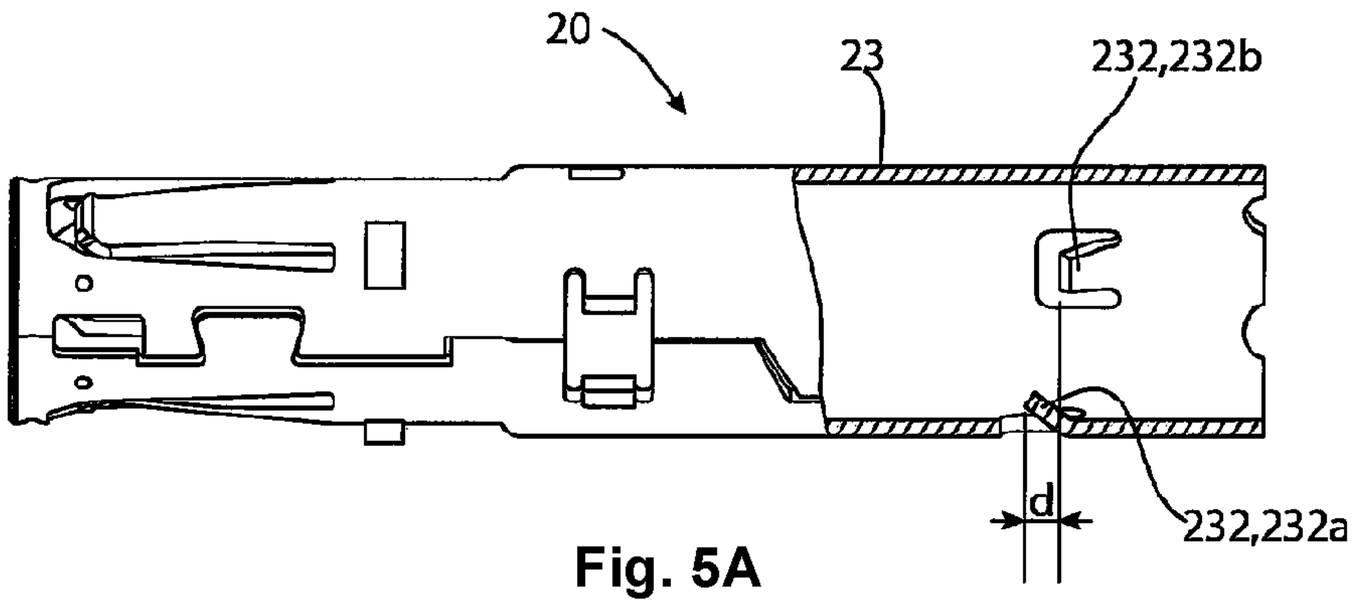

Fig. 5A

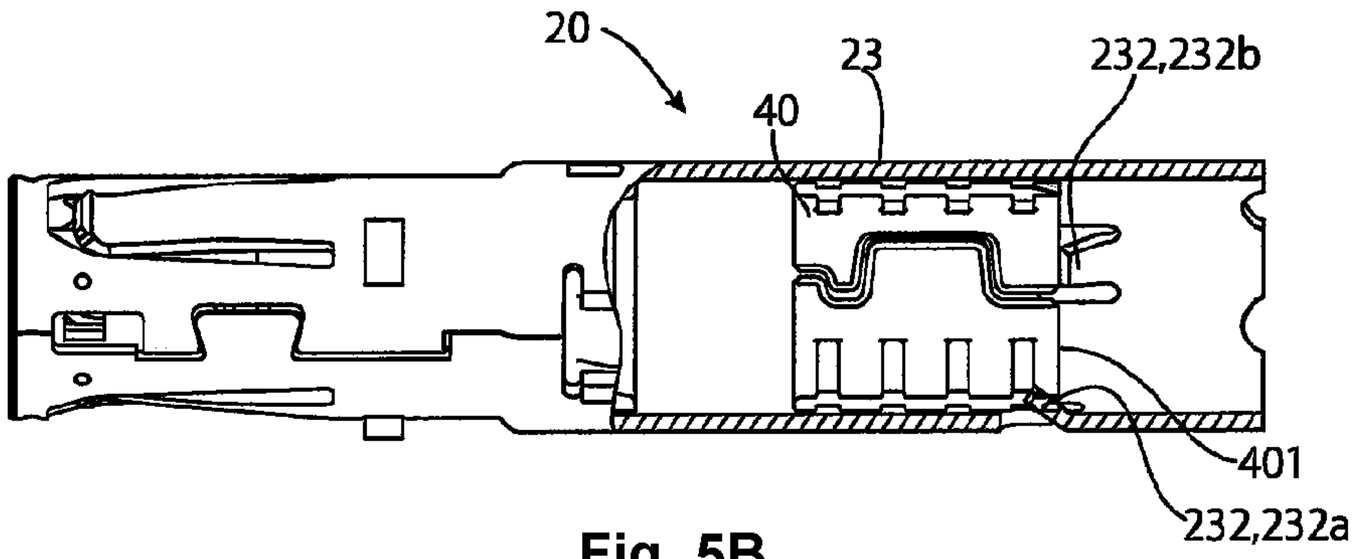

Fig. 5B

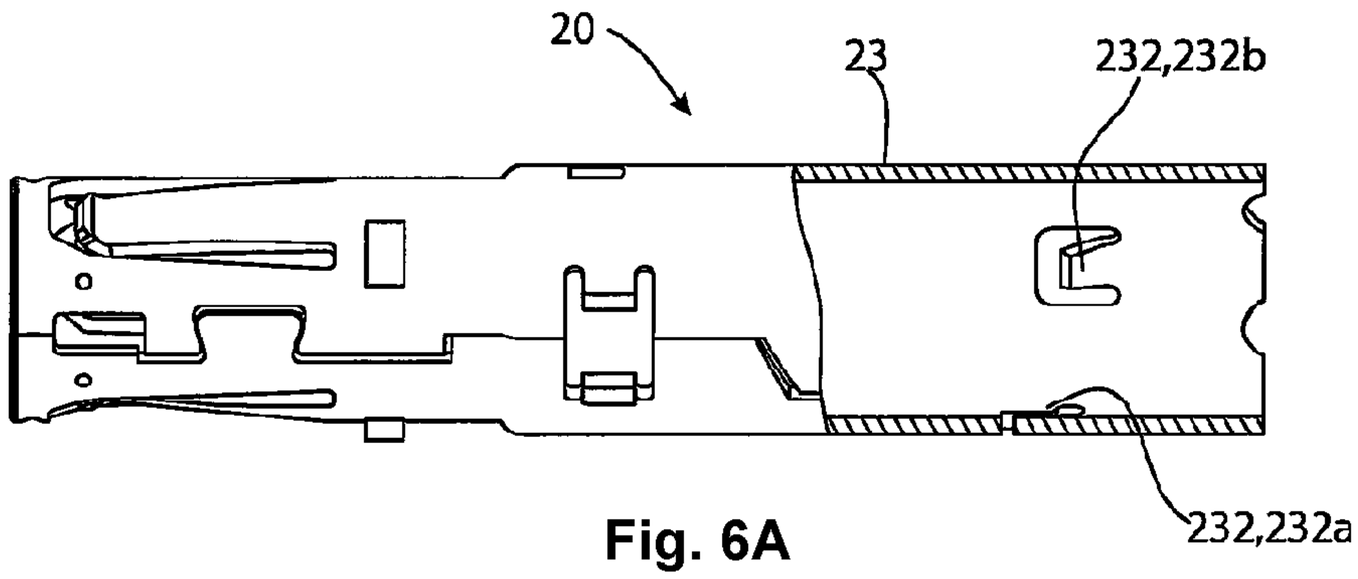

Fig. 6A

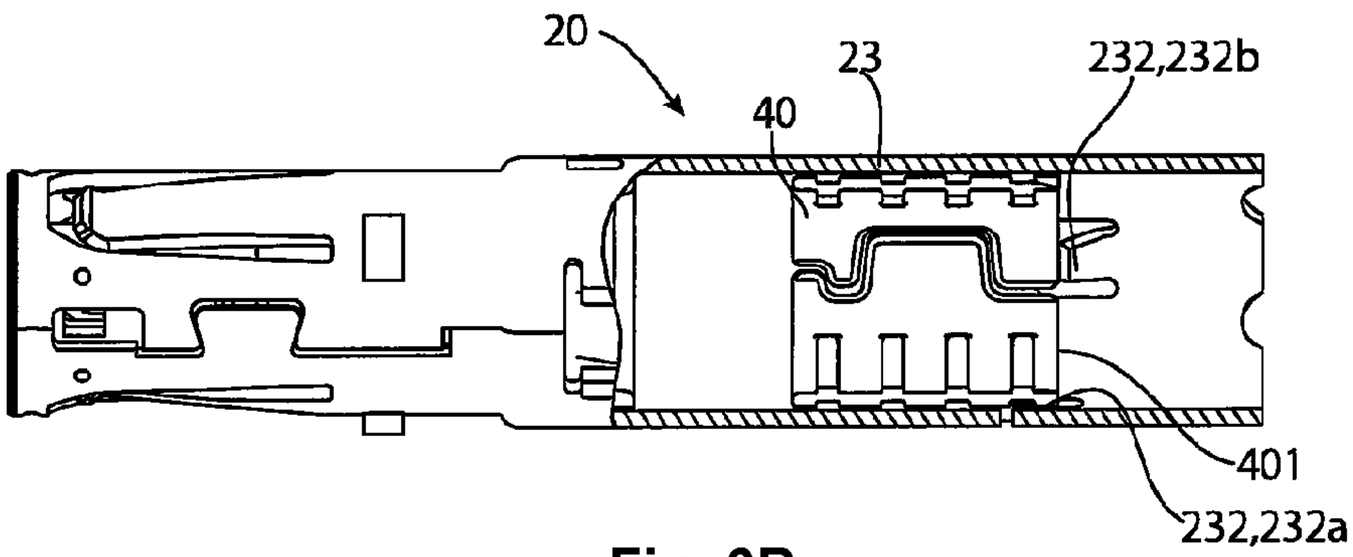

Fig. 6B

CABLE CONNECTOR ASSEMBLY

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of PCT International Application No. PCT/JP2020/040277, filed on Oct. 27, 2020, which claims priority under 35 U.S.C. § 119 to Japanese Patent Application No. 2019-199527, filed on Nov. 1, 2019.

FIELD OF THE INVENTION

The present invention relates to a cable connector assembly in which a coaxial connector is connected by crimping to a shielded cable.

BACKGROUND

When a cable connector assembly is manufactured, an inner conductor of a shielded cable (including a coaxial cable) is connected by crimping to an inner terminal of a coaxial connector. Then, the inner terminal is inserted into an insulating housing of the coaxial connector. Thereafter, an outer conductor of the shielded cable is connected by crimping to an outer terminal of the coaxial connector. Here, when the outer conductor of the shielded cable is connected by crimping to the outer terminal of the coaxial connector, a ferrule is used to avoid diameter reduction of an insulation layer due to crimping. In addition, it is desired that the role of catching on the outer terminal when a force that pulls the shielded cable out of the coaxial connector is applied to the shielded cable, thereby preventing the shielded cable from being pulled out, is also assigned to the ferrule.

Japanese Patent Application No. 2017-168440A discloses a cable connector assembly having a structure in which a locking protrusion provided on the ferrule is caught on a catching tab (locking lug) provided on the outer terminal of the coaxial connector, thereby preventing pullout.

The inner terminal is required to be positioned with high accuracy in a predetermined longitudinal position. Therefore, the inner terminal inserted into the insulating housing is located by abutment against a predetermined portion of the housing or otherwise. On the other hand, the ferrule is an element whose main purpose is to avoid diameter reduction of the insulation layer. Accordingly, quite a rough longitudinal position accuracy is allowed if it is only necessary to achieve this main purpose. However, if this ferrule is intended to serve a falling-out preventive purpose, the ferrule is also required to be located with high accuracy because it is necessary to prevent a longitudinal positional shift of the inner terminal. For example, the locking protrusion of the ferrule of JP 2017-168440A is required to be located accurately with respect to the catching tab (locking lug) of the outer terminal. This is because, if they are in positions distant longitudinally from each other, the inner terminal will shift its position significantly until the locking protrusion catches on the catching tab. In addition, if the lock protrusion is in a position behind the catching tab, the locking protrusion may fail to be caught thereon and the shielded cable may fall out.

In view of these circumstances, an object of the present invention is to provide a cable connector assembly having a reduced longitudinal mounting position accuracy of a ferrule and assigning a falling-out preventive role to the ferrule.

SUMMARY

A cable connector assembly includes a coaxial connector, a shielded cable, and a ferrule. The coaxial connector has an inner terminal, an insulating housing surrounding the inner terminal, and an outer terminal surrounding the insulating housing. The shielded cable has an inner conductor connected to the inner terminal, an insulation layer surrounding the inner conductor, and an outer conductor surrounding the insulation layer. The ferrule is positioned inside the outer terminal and crimped to the outer terminal. The outer terminal has a plurality of catching portions formed in different positions in an axial direction of the shielded cable and catching on the ferrule to restrain the shielded cable from being pulled out.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described by way of example with reference to the accompanying Figures, of which:

FIG. **1**A is a perspective view of a cable connector assembly according to an embodiment;

FIG. **1**B is a sectional side view of the cable connector assembly;

FIG. **2** is a perspective view of a coaxial connector and a shielded cable before assembly;

FIG. **3**A is a side view of the shielded cable with an inner terminal and a ferrule;

FIG. **3**B is a sectional side view of the coaxial connector;

FIG. **4**A is a side view of the shielded cable with the inner terminal and the ferrule in a short position;

FIG. **4**B is a side view of the shielded cable with the inner terminal and the ferrule in a long position;

FIG. **5**A is a partially sectional side view of the coaxial connector;

FIG. **5**B is a partially sectional side view of the coaxial connector with the ferrule in the long position of FIG. **4**B;

FIG. **6**A is a partially sectional side view of the coaxial connector after crimping; and

FIG. **6**B is a partially sectional side view of the coaxial connector after crimping with the ferrule in the long position of FIG. **4**B.

DETAILED DESCRIPTION OF THE EMBODIMENT(S)

An embodiment of the present invention will be described below.

A cable connector assembly **10**, shown in FIG. **1**A, comprises a coaxial connector **20**, a shielded cable **30**, and a ferrule **40**.

The coaxial connector **20** has an inner terminal **21**, an insulating housing **22**, and an outer terminal **23**, as shown in FIGS. **3**A and **3**B. In an embodiment, the inner terminal **21** is a female terminal, and is connected by crimping to an inner conductor **31** of the shielded cable **30**. The insulating housing **22** has an inner space **221**. The inner terminal **21** is inserted into the inner space **221**, and the insulating housing **22** surrounds the inner terminal **21**. In addition, the outer terminal **23** has a tubular shape, and surrounds the insulating housing **22**. The outer terminal **23** is connected to a carrier **50** in FIG. **2**.

As shown in FIG. **3**A, the shielded cable **30** has the inner conductor **31**, an insulation layer **32**, an outer conductor **33**, and a jacket **34**. As described above, the inner terminal **21** is connected by crimping to the inner conductor **31**. The insulation layer **32** surrounds the inner conductor **31**. The outer conductor **33** surrounds the insulation layer **32**. Furthermore, the jacket **34** surrounds the outer conductor **33**.

The ferrule **40** is positioned around the outer conductor **33**, as shown in FIG. **3**A.

At the time of assembling the shield connector assembly **10**, the insulation layer **32** is cut off to expose a leading end portion of the inner conductor **31** of the shielded cable **30**. Then, the jacket **34** is cut off to expose the outer conductor **33**. Then, the ferrule **40** is mounted to a portion where the jacket **34** is cut off and the outer conductor **33**, the insulation layer **32**, and the inner conductor **31** remain. Then, a portion in front of the ferrule **40** of the outer conductor **33** is folded back over the ferrule **40**. The outer conductor **33** in the folded state is shown in FIG. **2**. Therefore, the ferrule **40** is covered with the outer conductor **33** and is not shown in FIG. **2**. In order to illustrate the ferrule **40**, the folded portion of the outer conductor **33** is not shown in FIGS. **3**A and **3**B and in FIGS. **4**A and **4**B and the subsequent drawings described later. Then, the inner terminal **21** is connected by crimping to the inner conductor **31** as shown in FIG. **3**A.

The shielded cable **30** processed up to this stage is shown in FIG. **2**.

The inner terminal **21** connected by crimping to the inner conductor **31** of the shielded cable **30** is inserted into the insulating housing **22** positioned inside the outer terminal **23**. The inner terminal **21** is inserted into the insulating housing **22**, and an abutting portion **211** of the inner terminal **21** is abutted against a locating wall **222** (see FIG. **3**B) of the insulating housing **22**. Thereby, the inner terminal **21** is positioned in an accurate position.

At the time of this insertion, the outer terminal **23** has a rear portion **231** in an expanded state, as shown in FIG. **2**. The inner terminal **21** is inserted into the insulating housing **22** inside the outer terminal **23** in this state, and the rear portion **231** of the outer terminal **23** is crimped to the outer conductor **33** folded over the ferrule **40** (see FIG. **3**A). Since the ferrule **40** is positioned, the insulation layer **32** is not crushed and retains its original diameter. The coaxial connector **20** in a shape after crimping is shown in FIG. **1**A.

As shown in FIGS. **1**A and **1**B, a catching portion **232** is formed on the outer terminal **23**. This catching portion **232** is a protrusion which is lanced inward in the form of a cantilever and which extends obliquely inward in a direction where its rear end serves as a fixed end and its front end serves as a free end. As shown in FIGS. **3**A and **3**B, in comparison between a length A from the abutting portion **211** of the inner terminal **21** to a rear end edge **401** of the ferrule **40** and a length B from the locating wall **222** of the insulating housing **22** to the catching portion **232**, the length B is a little longer than the length A. Accordingly, this catching portion **232** is positioned immediately behind the rear end edge **401** of the ferrule **40**, as shown in FIG. **1**B. Here assume that a force in the direction of an arrow R shown in FIG. **1**B, namely a force in the direction of pulling the shielded cable **30** out of the coaxial connector **20**, is applied to the shielded cable **30**. Thereupon, the rear end edge **401** of the ferrule **40** is caught on the catching portion **232**, and the shielded cable **30** is prevented from falling out. The ferrule **40** moves only a small distance rearward until it is caught on the catching portion **232** immediately therebehind, but such a moving amount is within the margin of error of the arrangement position of the inner terminal **21**, and does not cause any functional problem.

Here, the catching portion **232** is formed at a plurality of locations (two locations in the present embodiment) different in the longitudinal direction. The reason will be explained below.

FIGS. **4**A and **4**B are diagrams illustrating variation in the position of the ferrule **40**.

The ferrule **40** varies significantly in length from the abutting portion **211** of the inner terminal **21** to the rear end portion **401** of the ferrule **40** within a range from A Short shown in FIG. **4**A to A Long shown in FIG. **4**B. Assume that the catching portion **232** is provided at only one longitudinal location. Then assume that this catching portion **232** is positioned immediately behind the rear end edge **401** of the ferrule **40** in the A Long position shown in FIG. **4**B. At this time, if the ferrule **40** is in the A Short position shown in FIG. **4**A, when a force in the pullout direction is applied to the shielded cable **30**, the inner terminal **21** moves significantly until the rear end edge **401** of the ferrule **40** is caught on the catching portion **232**. The length of this movement is a length that can cause the coaxial connector **20** to lose its normal function.

In contrast, assume that the catching portion **232** at the only one location is positioned immediately behind the rear end edge **401** of the ferrule **40** in the A Short position shown in FIG. **4**A. Then assume that the ferrule **40** is in the A Long position shown in FIG. **4**B. This means that the ferrule **40** and the catching portion **232** overlap with each other. In this case, the rear end edge **401** of the ferrule **40** cannot be caught on the catching portion **232**, and the shielded cable **30** and the inner terminal **21** may fall out of the coaxial connector **20**.

Therefore, the catching portion **232** is provided at two longitudinal locations in the present embodiment.

Two catching portions **232** are shown in FIGS. **5**A and **5**B. These two catching portions **232** are provided in positions shifted longitudinally by a distance d, as shown in FIG. **5**A. This distance d is a distance the internal terminal **21** moves without influence on the function. The catching portions **232** are formed at mutually different positions in the axial direction.

As shown in FIG. **5**B, a front catching portion **232***a* of these two catching portions **232** is in a position overlapping with the ferrule **40** in the A Long position. On the other hand, a rear catching portion **232***b* is positioned immediately behind the ferrule **40** in the A Long position. Therefore, the rear catching portion **232***b* fulfills a pullout preventive role even when the ferrule **40** is in the A Long position.

FIGS. **6**A and **6**B show the catching portion **232** after crimping. The catching portion **232** is a protrusion which is lanced inward in the form of a cantilever and which extends obliquely inward in a direction where its rear end serves as the fixed end and its front end serves as the free end, as shown in FIGS. **5**A and **5**B. Therefore, the catching portion **232***a* in the position overlapping with the ferrule **40** is pressed back and returns, by crimping, to its prior-to-lancing shape that does not interfere with crimping at all.

If the ferrule **40** is in the A Short position shown in FIG. **4**A, the front catching portion **232***a* fulfills a falling-out preventive role. When a pullout force acts, the ferrule **40** is caught on any one of the catching portions **232**, thereby preventing a positional shift beyond an allowable range and pullout of the inner terminal **21**.

It should be noted that the catching portion **232** is provided at two longitudinal locations in the present embodiment, but the catching portion **232** is not limited to two locations. The catching portion **232** may be provided at three or more locations with the range of variation in the mounting position of the ferrule **40** and the allowable range of a positional shift of the internal terminal **21** taken into consideration.

According to the cable connector assembly **10** of the present invention described above, a falling-out preventive role can be assigned to the ferrule **40** despite the low longitudinal mounting position accuracy of the ferrule **40**.

What is claimed is:

1. A cable connector assembly, comprising:

a coaxial connector having an inner terminal, an insulating housing surrounding the inner terminal, and an outer terminal surrounding the insulating housing, the inner terminal positionable within insulating housing within a predetermined range of longitudinal positions in an axial direction of the shielded cable wherein proper functionality of the coaxial connector is realized;

a shielded cable having an inner conductor connected to the inner terminal, an insulation layer surrounding the inner conductor, and an outer conductor surrounding the insulation layer; and

a ferrule positioned inside the outer terminal and crimped to the outer conductor in a longitudinal position adapted to maintain the inner terminal in the predetermined range of longitudinal positions, the outer terminal has a plurality of catching portions formed in different positions in an axial direction of the shielded cable and adapted to catch on an axially facing end of the ferrule to restrain the shielded cable from being pulled out and prevent the inner terminal from being displaced into a position outside of the predetermined range of longitudinal positions, wherein a first catching portion and a second catching portion of the plurality of catching portions are separated in the longitudinal direction by a predetermined distance corresponding to the predetermined range of longitudinal positions of the inner terminal, such that the inner terminal remains in the predetermined range of longitudinal positions with the axially facing end of the ferrule engaged with either of the first catching portion or the second catching portion.

2. The cable connector assembly of claim 1, wherein the catching portion has a rear end that is a fixed end and a front end as a free end.

3. The cable connector assembly of claim 2, wherein the first catching portion is arranged closer to a free end of the inner terminal than the second catching portion.

4. The cable connector assembly of claim 3, wherein each of the plurality of catching portions is a protrusion extending obliquely inward.

5. The cable connector assembly of claim 4, wherein, with the axially facing end of the ferrule engaged with the first catching portion, the second catching portion is not engaged with the ferrule.

6. The cable connector assembly of claim 3, wherein, with the axially facing end of the ferrule engaged with the second catching portion, the first catching portion is deformed outwardly by a force exerted by the ferrule after crimping of the outer terminal.

7. A cable connector assembly, comprising:

a coaxial connector having an inner terminal, an insulating housing surrounding the inner terminal, and an outer terminal surrounding the insulating housing, the inner terminal positionable within insulating housing within a predetermined range of longitudinal positions in an axial direction of the shielded cable wherein proper functionality of the coaxial connector is realized; and

a ferrule positioned inside the outer terminal and adapted to be crimped to an outer conductor of a shielded cable in a longitudinal position which maintains the inner terminal in the predetermined range of longitudinal positions, the outer terminal has a first catching portion and a second catching portion formed in different positions in an axial direction of the connector and catching on the ferrule to prevent the inner terminal from being displaced a position outside of the predetermined range of longitudinal positions, wherein a first catching portion and a second catching portion of the plurality of catching portions are separated in the longitudinal direction by a predetermined distance corresponding to the predetermined range of longitudinal positions of the inner terminal such that the inner terminal remains in the predetermined range of longitudinal positions with a rear facing end of the ferrule engaged with either of the first catching portion or the second catching portion.

8. The cable connector assembly of claim 7, wherein the first and second catching portions each has a rear end that is a fixed end and a front end as a free end.

9. The cable connector assembly of claim 8, wherein the first catching portion is arranged closer to a free end of the inner terminal than the second catching portion.

10. The cable connector assembly of claim 9, wherein at least one of the first and second catching portions is a protrusion extending obliquely inward.

11. The cable connector assembly of claim 10, wherein, with the axially facing end of the ferrule engaged with the first catching portion, the second catching portion is not engaged with the ferrule and extends obliquely inwardly.

12. The cable connector assembly of claim 10, wherein, with the axially facing end of the ferrule engaged with the second catching portion, the first catching portion abuts an intermediate portion of the ferrule and does not extend obliquely inwardly.

13. The cable connector assembly of claim 7, further comprising a shielded cable having an inner conductor connected to the inner terminal.

14. The cable connector assembly of claim 13, wherein the shielded cable has an insulation layer surrounding the inner conductor and an outer conductor surrounding the insulation layer.

15. A method of forming a cable connector assembly comprising the steps of:

connecting an inner terminal of a coaxial connector to an inner conductor of a shielded cable;

positioning the inner terminal within an insulating housing of the coaxial connector and inside of an outer terminal of the coaxial connector, the inner terminal positioned within the insulating housing within a predetermined range of longitudinal positions in an axial direction of the shielded cable wherein proper functionality of the coaxial connector is realized;

crimping a ferrule onto an outer conductor of the shielded cable in a longitudinal position adapted to maintain the inner terminal in the predetermined range of longitudinal positions; and

crimping the outer terminal onto the ferrule, the outer terminal having a first catching portion and a second catching portion formed in different positions in an axial direction of the connector and catching on the ferrule to prevent the inner terminal from being displaced a position outside of the predetermined range of longitudinal positions, wherein a first catching portion and a second catching portion of the plurality of catching portions are separated in the longitudinal direction by a predetermined distance corresponding to the predetermined range of longitudinal positions of the inner terminal such that the inner terminal remains in the predetermined range of longitudinal positions with

a rear facing end of the ferrule engaged with either of the first catching portion or the second catching portion.

16. The method of claim **15**, wherein:

the first catching portion is formed closer to a free end of the inner terminal than the second catching portion; and

each catching portion includes a protrusion having a free end extending obliquely inward.

17. The method of claim **16**, wherein the step of crimping the outer terminal includes engaging the axially facing end of the ferrule with the free end of the first catching portion, wherein the second catching portion is not engaged with the ferrule.

18. The method of claim **16**, wherein the step of crimping the outer terminal includes:

engaging the axially facing end of the ferrule with the free end of the second catching portion; and

engaging the free end of the first catching portion with an intermediate portion of the ferrule, wherein the ferrule deforms the free end of the first catching portion outwardly in a direction away from the ferrule.

* * * * *